Profile SFR-54

SOFUS

Republic of KOREA

GENERAL INFORMATION

NAME OF THE FACILITY	SOFUS
ACRONYM	SOdium test Facility for Under-Sodium visualization
COOLANT(S) OF THE FACILITY	Liquid Sodium
LOCATION (address):	Korea Atomic Energy Research Institute, Fast Reactor Technology Demonstration Division, 989-111 Daedeok-daero, Yuseong-gu, Daejeon, Republic of Korea
OPERATOR	KAERI
CONTACT PERSON (name, address, institute, function, telephone, email):	Young-Sang Joo, 989-111 Daedeok-daero, Yuseong-gu, Daejeon, Republic of Korea, Korea Atomic Energy Research Institute, Principal researcher, Tel. +82 42 868 8239 ysjoo@kaeri.re.kr

STATUS OF THE FACILITY In operation

Start of operation (date): 2010

MAIN RESEARCH FIELD(S)

- ☐ Zero power facility for V&V and licensing purposes
- ☐ Design Basis Accidents (DBA) and Design Extended Conditions (DEC)
- ☐ Thermal-hydraulics
- ☐ Coolant chemistry
- ☐ Materials
- ☐ Systems and components
- ☒ Instrumentation & ISI&R

TECHNICAL DESCRIPTION

Description of the facility

SOFUS was designed and manufactured to conduct the performance test of the under-sodium ultrasonic sensor in a sodium environment. SOFUS consists of a glove box with an anti-chamber, a sodium test tank with a volume of 30 liters, a sodium storage tank with a volume of around 70 liters, an electric resistance heater, a heater control unit, an argon (Ar) circulation and cooling system, an XYZ scanning system. The XYZ scanning system is comprised of the XYZ scanner and the scanning control and mapping system. The range of the distance for the movement of the XYZ scanning system in the sodium test tank is 200 mm

x 200 mm x 450 mm with 0.1 mm resolution. All components of the SOFUS in contact with sodium or sodium vapor were made of Type 304 austenitic stainless steel. The sodium test tank for conducting the under-sodium beam profile measurement and C-scan test is enclosed in a glove box system providing a volume of 1200 mm x 800 mm x 1000 mm. The sodium test tank is a vertical cylindrical vessel, whose dimensions are 300 mm in diameter and 550 mm in height. In the glove box system, an argon gas is used as an inert cover gas. The argon gas is circulated to provide the cooling of the glove box system. A cover gas purification system was also installed on the glove box to maintain an atmospheric purity of 1 ppm of oxygen and 0.1 ppm of moisture during the sodium experiments. The basic performance test of the under-sodium ultrasonic sensor in SOFUS was completed in the end of 2010 and the main experiments have been conducted since 2011.

Acceptance of radioactive material

No

Scheme/diagram

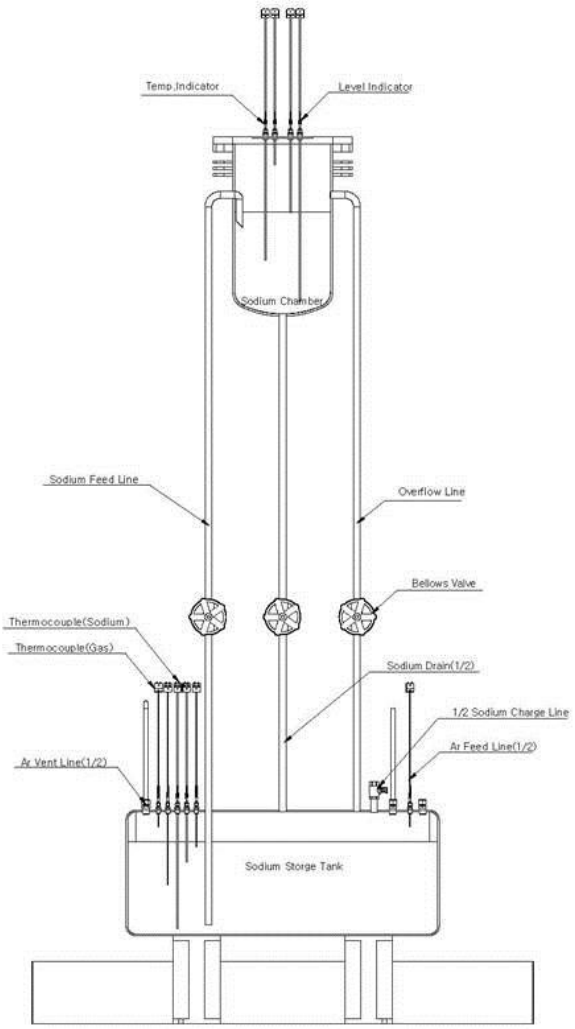

FIG. 1. Scheme of sodium loop of SOFUS

3D drawing/photo

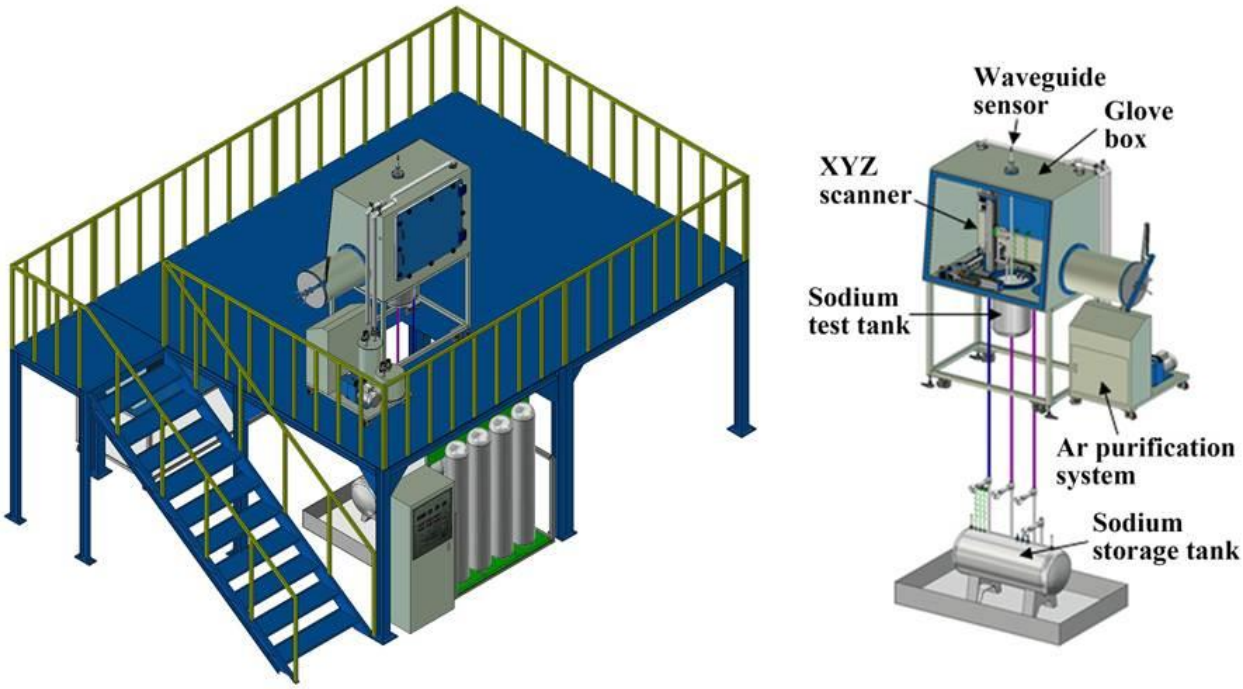

FIG. 2. 3D drawing and photo of SOFUS

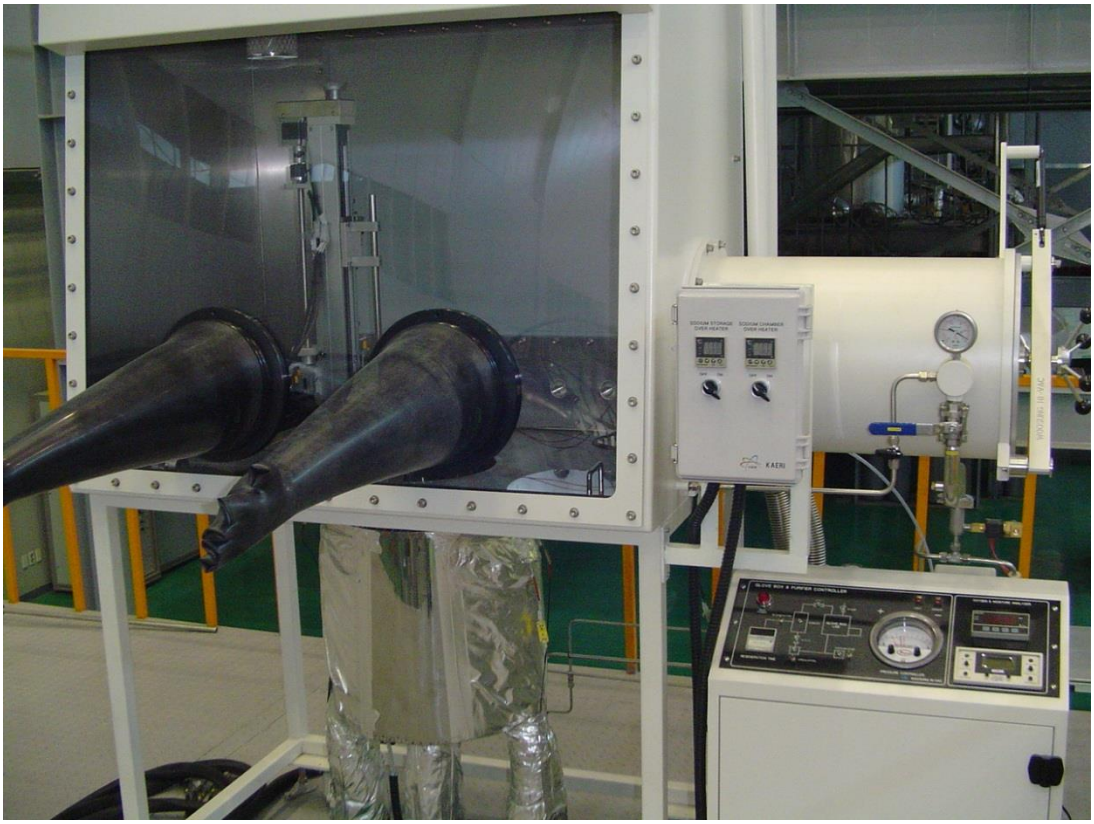

FIG. 3. Glove box and argon circulation/cooling system

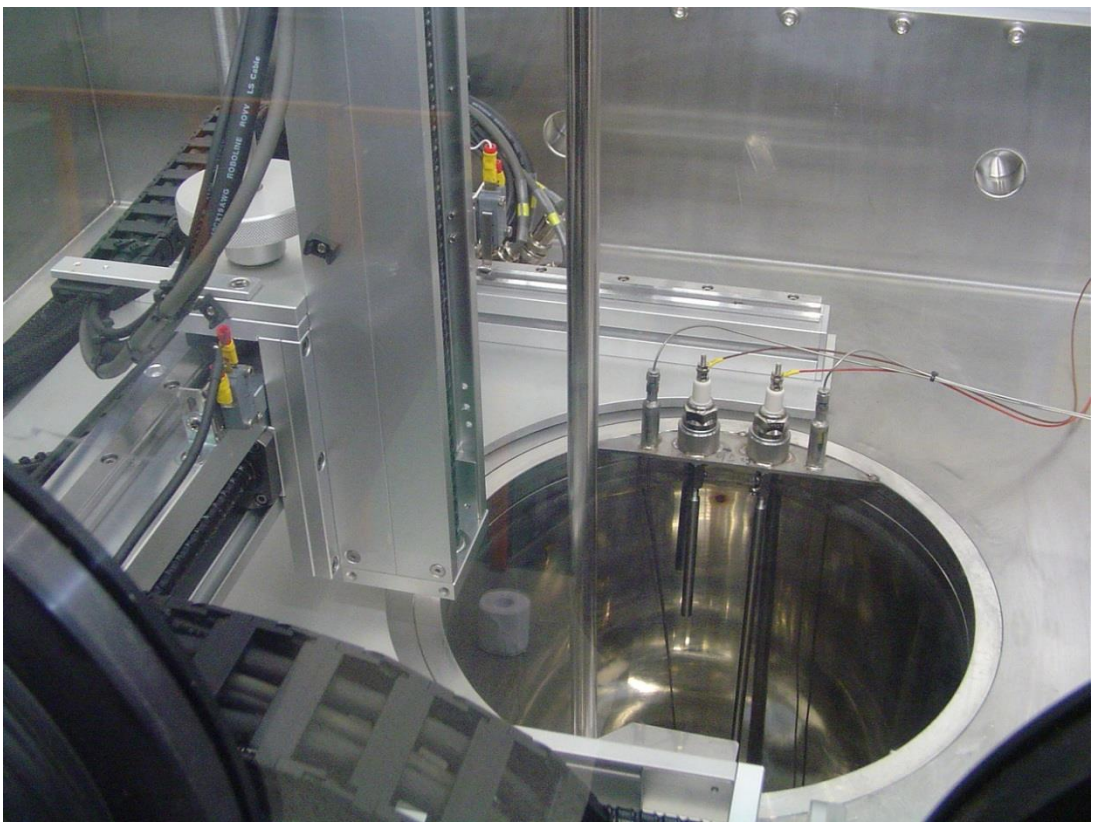

FIG. 4. Sodium test tank

Parameters table

Coolant inventory	Max sodium inventory → around 70 kg
Power	18 kW
Test sections	
TS #1	*Characteristic dimensions* Width → 6100 mm Length → 4000 mm Overall height → 3800 mm
	Static/dynamic experiment Static
	Temperature range in the test section (Delta T) 200°C ~ 250°C
	Operating pressure and design pressure Operating Pressure → 1.1 atm Design pressure → 1.5 atm
	Flow range (mass, velocity, etc.) None
Coolant chemistry measurement and control (active or not, measured parameters)	Not measured
Instrumentation	Thermocouples, Oxygen sensor, Gas injection system, humidity sensor, level gauge sensors, XYZ scanning/mapping system

COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

Several performance tests of under-sodium ultrasonic waveguide sensors were carried out in SOFUS. The length of the under-sodium waveguide sensor was 10 m and thin beryllium (0.25 mm) and nickel (0.1 mm) layers were coated at both surfaces of the radiation end section of the sensor by the brazing technique. The signal sensitivity and beam profile measurements and C-scan test were carried out in a sodium environment. A signal-to-noise ratio higher than 10 dB was achieved and 1 mm wide slit was detected in 200°C liquid sodium. Recently, the performance test of the new version of under-sodium ultrasonic waveguide sensor which employs the diffusion bonding technique to attach thin beryllium and nickel layers onto the radiation surfaces of the sensor has been conducted in SOFUS. Since the diffusion bonding technique does not need a filler metal, ultrasonic wave transmission property can be considerably improved. A signal-to-noise ratio higher than 16 dB was achieved and 0.5 mm wide slit was well detected in 200°C liquid sodium.

PLANNED EXPERIMENTS (including time schedule)

The performance test of the new version of diffusion bonded under-sodium ultrasonic waveguide sensor will be conducted in 2015. And the performance of the high temperature

ultrasonic immersion sensor that has been developing since the end of 2013 will also be investigated in 2016.

TRAINING ACTIVITIES

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REFERENCES (*specification of availability and language*)

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3. JOO Y.S., LIM S.H., PARK C.G., LEE J.H., "Feasibility study on ultrasonic waveguide sensor for under-sodium viewing of reactor internals in sodium-cooled fast reactor", Journal of the Korean Society for Nondestructive Testing 28, pp. 346-371, 2008. (Kr)
4. JOO Y.S., PARK C.G., LEE J.H., KIM J.B., LIM S.H., "Development of ultrasonic waveguide sensor for under-sodium inspection in a sodium-cooled fast reactor", NDT&E International 44, pp. 239-246, 2011. (En)
5. JOO Y.S., BAE J.H., PARK C.G., KIM J.B., "Development of Plate Ultrasonic Waveguide Sensor and Performance Test in Sodium", KAERI/TR-4545/2011, 2011. (En)
6. JOO Y.S., "Under-sodium viewing techniques in sodium-cooled fast reactors", Journal of the Korean Society for Nondestructive Testing 32, pp. 439-447, 2012. (Kr)
7. JOO Y.S., BAE J.H., KIM J.B., KIM J.Y., "Effect of beryllium coating layer on performance of the ultrasonic waveguide sensor", Ultrasonics 53, pp. 387-389, 2013. (En)
8. KIM H.W., JOO Y.S., PARK C.G., KIM J.B., BAE J.H., "Ultrasonic Imaging in Hot Liquid Sodium Using a Plate-Type Ultrasonic Waveguide Sensor", Journal of Nondestructive Evaluation 33, pp. 676-683, 2014. (En)